



Welcome remarks and update

Haiyan Gao

Nuclear and Particle Physics, BNL
RHIC & AGS Users' Meeting

June 10, 2021



BNL anti-harassment policy

At Brookhaven National Laboratory (BNL) or BNL-sponsored events,

“Discriminatory behavior or harassment of conference participants or presenters will not be tolerated.”

Please refer to the poster on the Annual Users' Meeting website under Participant Information

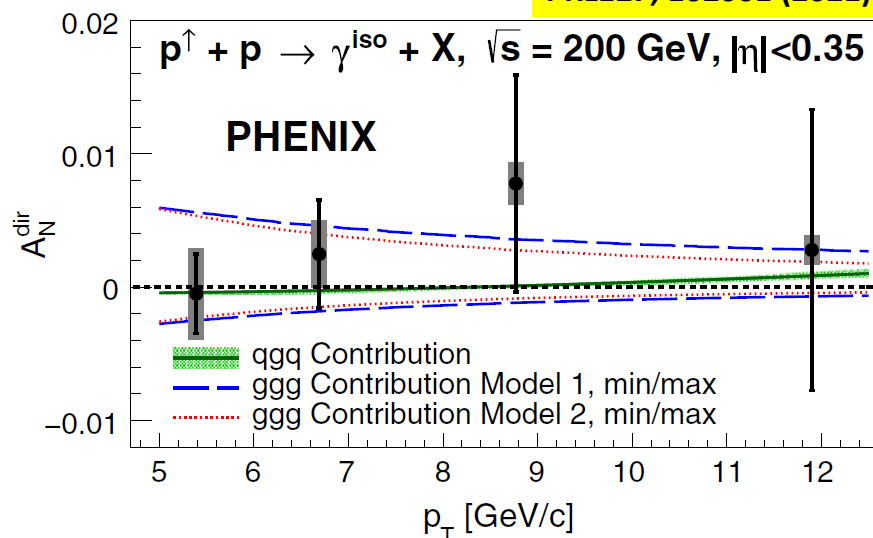
COVID, Safety, DEI

- **More than two years since the beginning of COVID-19 global pandemic**
 - Collectively we overcome many challenges and accomplished a lot
 - Unfortunately, COVID is not over yet and challenges will continue
 - The new norm of “normal operations with telework”
- **Safety is a core value and a priority**
 - Many safety events including several electrical events last fall
 - Department, directorate, and laboratory wide actions taken
 - Safety culture, work planning and control, human performance improvement
 - Improvements and thank you all for your effort as users (DeepDive Survey conducted Jan/Feb 2022, results in April 2022)
- **Diversity, Equity and Inclusion is a core value**
 - Collaborations with users in our DEI efforts
 - Pipeline: Nuclear Physics Traineeship (NPT) Program, SULI, SCGSR and more
 - Developing Code of Conduct with user group leadership engagement
 - 2022 Jan –Feb BNL Culture IQ DeepDive Survey

Highlights of Recent PHENIX Results

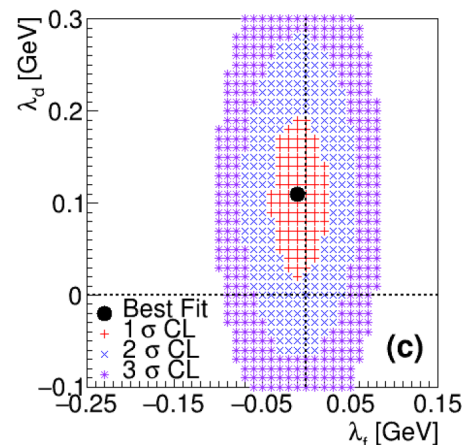
Spin Physics highlights

PRL127, 162001 (2021)



- Measurement of Direct photon A_N
- Constraint on gluon's dynamic motion in the proton
- News release at BNL and RIKEN

arXiv:2204.12899 (2022)



$A_N(p^\uparrow + p \rightarrow HF(e^{+/-}) + X)$

$\sqrt{s} = 200 \text{ GeV}$

$|\eta| < 0.35$

PHENIX

Theory: PRD78, 114013

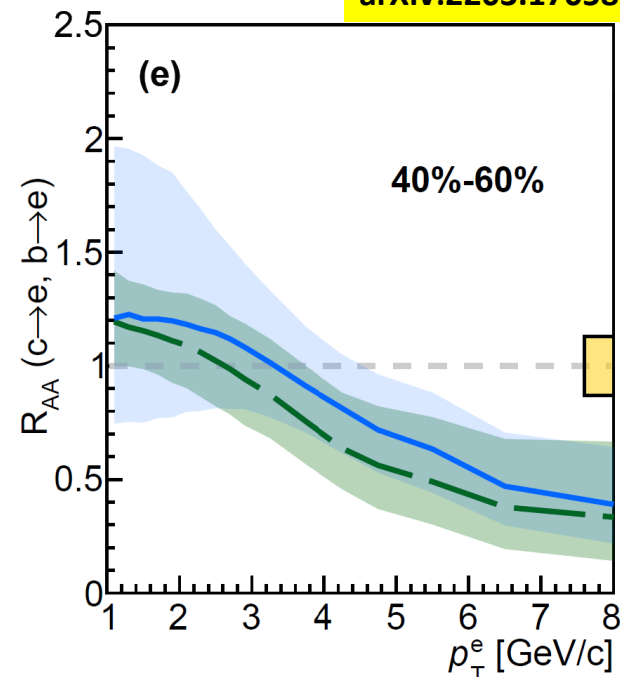
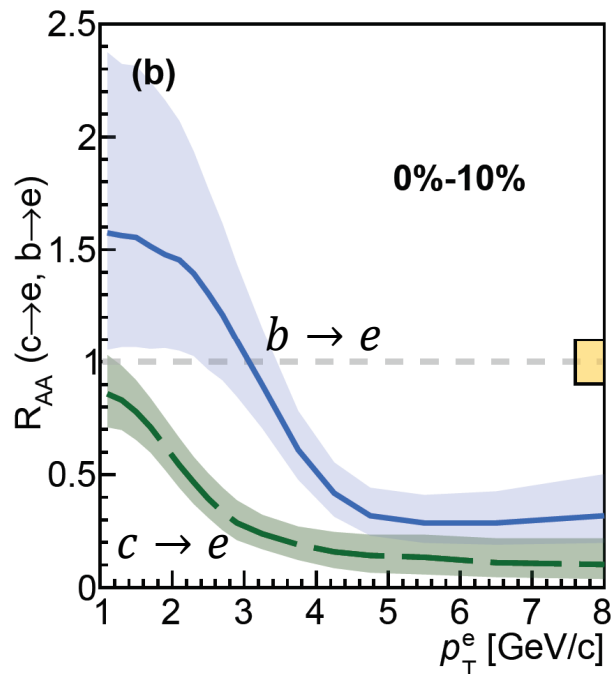
$A_N^{D^0/\bar{D}^0 \rightarrow e^{+/-}}(\lambda_p, \lambda_d)$

- Measurement of A_N of heavy-flavor decay electrons
- Constraint on parameters of Tri-Gluon model
- Submitted to PRL

Highlights of Recent PHENIX Results

R_{AA} of $b \rightarrow e$ and $c \rightarrow e$

arXiv:2203.17058



- R_{AA} of $b \rightarrow e$ and $c \rightarrow e$ at midrapidity from 20B Au+Au data
- Clear difference of charm and bottom suppression is seen
- Next: 2014+2016 Au+Au data analysis

STAR Highlights : Helicity PDFs: ΔG

Golden probes for Δg :

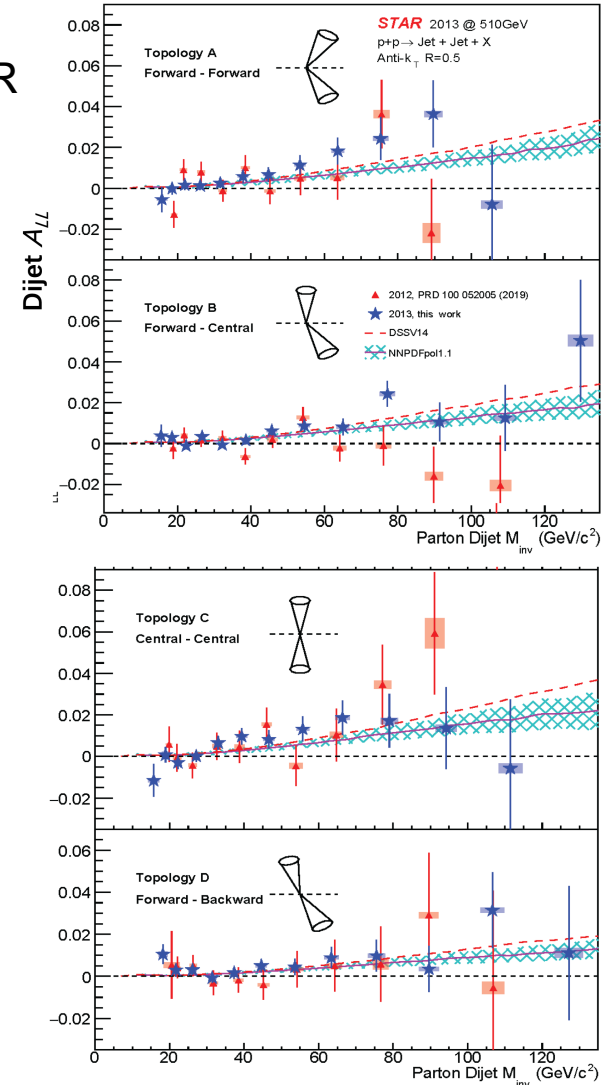
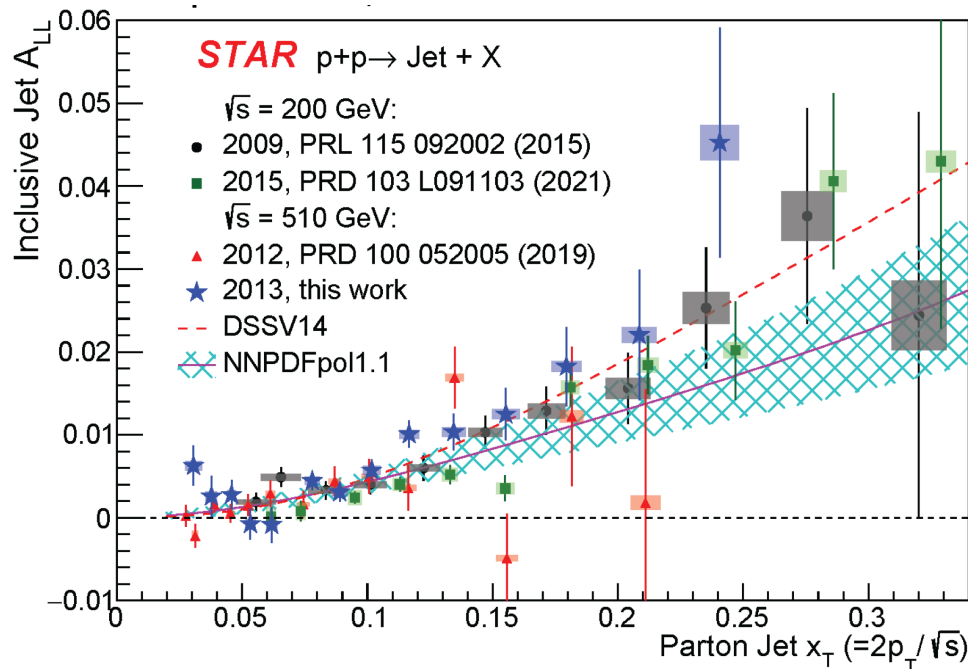
Double spin asymmetry A_{LL} for jets, di-jets and π^0

Remember: to increase x-range covered: go to higher \sqrt{s} (200 GeV \rightarrow 500 GeV)

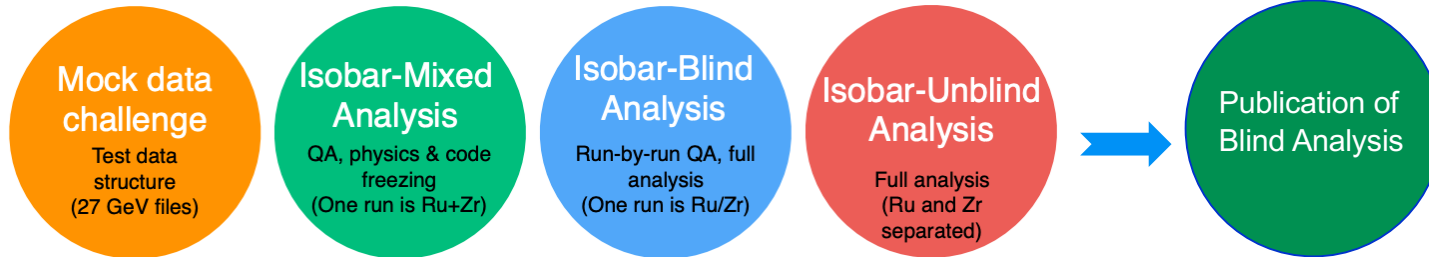
or
go to higher rapidity: $-1 < \eta < 1 \rightarrow -1 < \eta < 1.8$ ($-1 < \eta < 4$ with fSTAR)
or both

Di-jets: constrain the shape of the $\Delta g(x, Q^2)$

\rightarrow 5 papers in the last years \rightarrow still ~ 2 papers to come

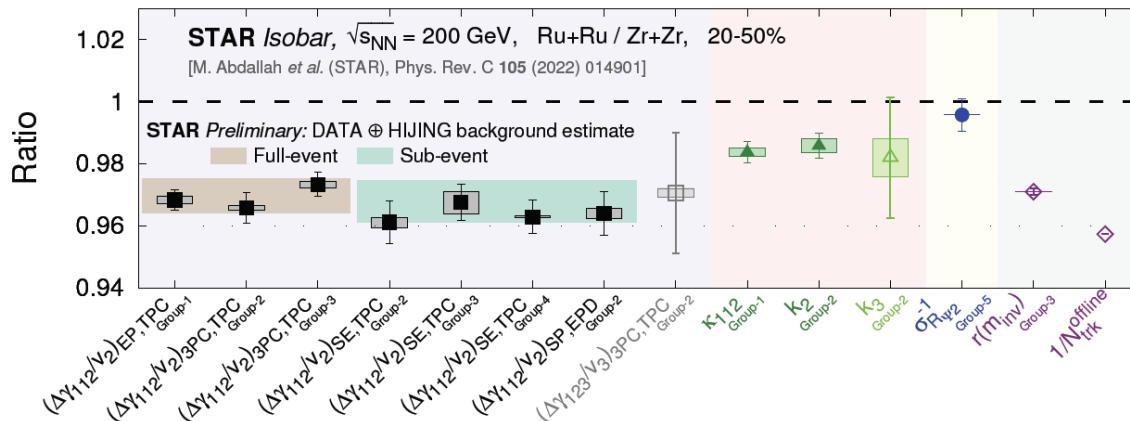


Blinding Analysis of CME Search with Isobar Data



STAR, PRC 105 (2022) 014901

Pre-defined signature of CME: $\frac{\langle \text{Observable} \rangle_{\text{Ru+Ru}}}{\langle \text{Observable} \rangle_{\text{Zr+Zr}}} > 1$



Updated estimate on non-flow combining data/HIJING consistent with isobar data of $\Delta\gamma/v_2$

Hints of signals in Au+Au 200GeV:
PRL 128 (2022) 092301
arXiv: 2006.05035

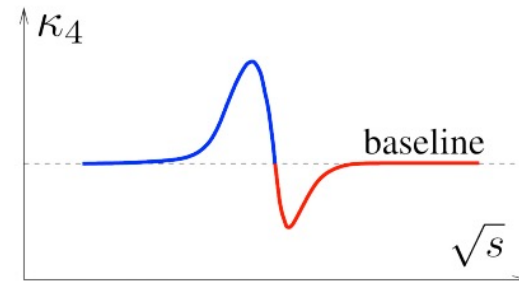
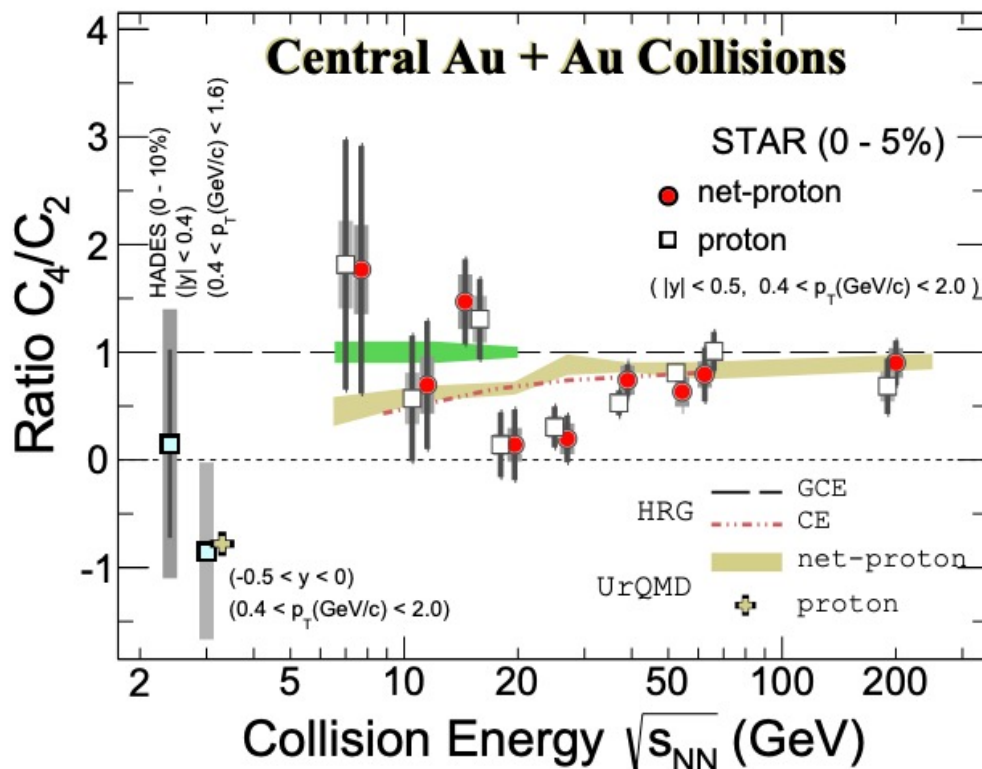
June 2, 2022

BNL NPP PAC Meeting

X. Dong

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Energy Dependence of (Net-) Proton High Moments



- Non-monotonic energy dependence in central Au+Au collisions (3.1σ)
- Strong suppression in proton C_4/C_2 at 3 GeV
- consistent with UrQMD hadronic transport model calculation

BES-I: PRL 126 (2021) 092301
3 GeV data: PRL 128 (2022) 202303

Budget

- The FY22 budget is better than what could have been a lot worse – RHIC Run 2022 was extended by two weeks thanks to DOE – a huge impact on achieving physics goals
- FY23 President's budget request was announced on Monday, March 28th. The DOE Office of Science proposed budget is available here at <https://www.energy.gov/science/office-science-budget>.
- Reports from the NSF and the DOE (upcoming presentations)

RHIC in the 2015 NSAC Long Range Plan

“There are two central goals of measurements planned at RHIC, as it completes its scientific mission, and at the LHC:

- (1) Probe the inner workings of QGP by resolving its properties at shorter and shorter length scales. The complementarity of the two facilities is essential to this goal, as is a state-of-the-art jet detector at RHIC, called sPHENIX.**
- (2) Map the phase diagram of QCD with experiments planned at RHIC.”**

RHIC Run-2021

Last, lowest (~40% of nominal injection energy), and most difficult colliding Au+Au BES-II energy -- second year with low-energy electron cooler (LEReC, PI: Alexei Fedotov)

Run Coordinator: Chuyu Liu (Run-19 to 21)

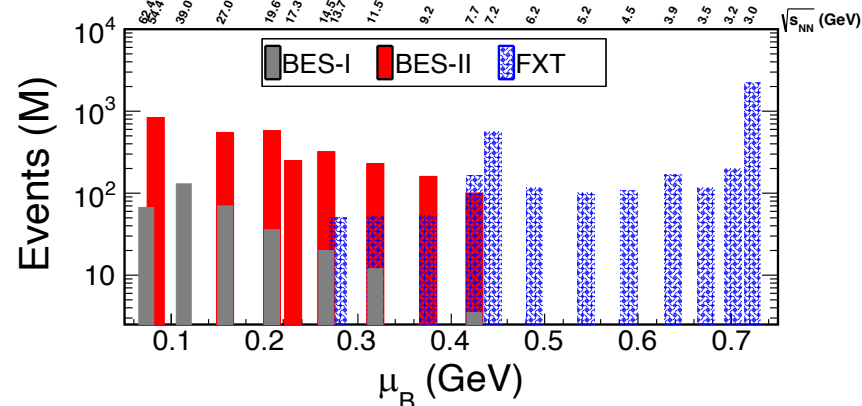
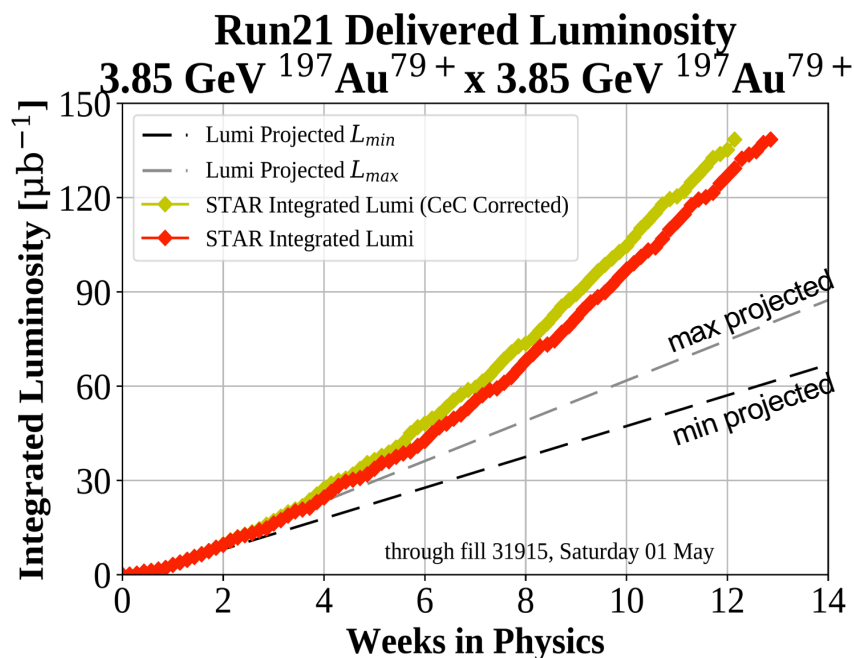


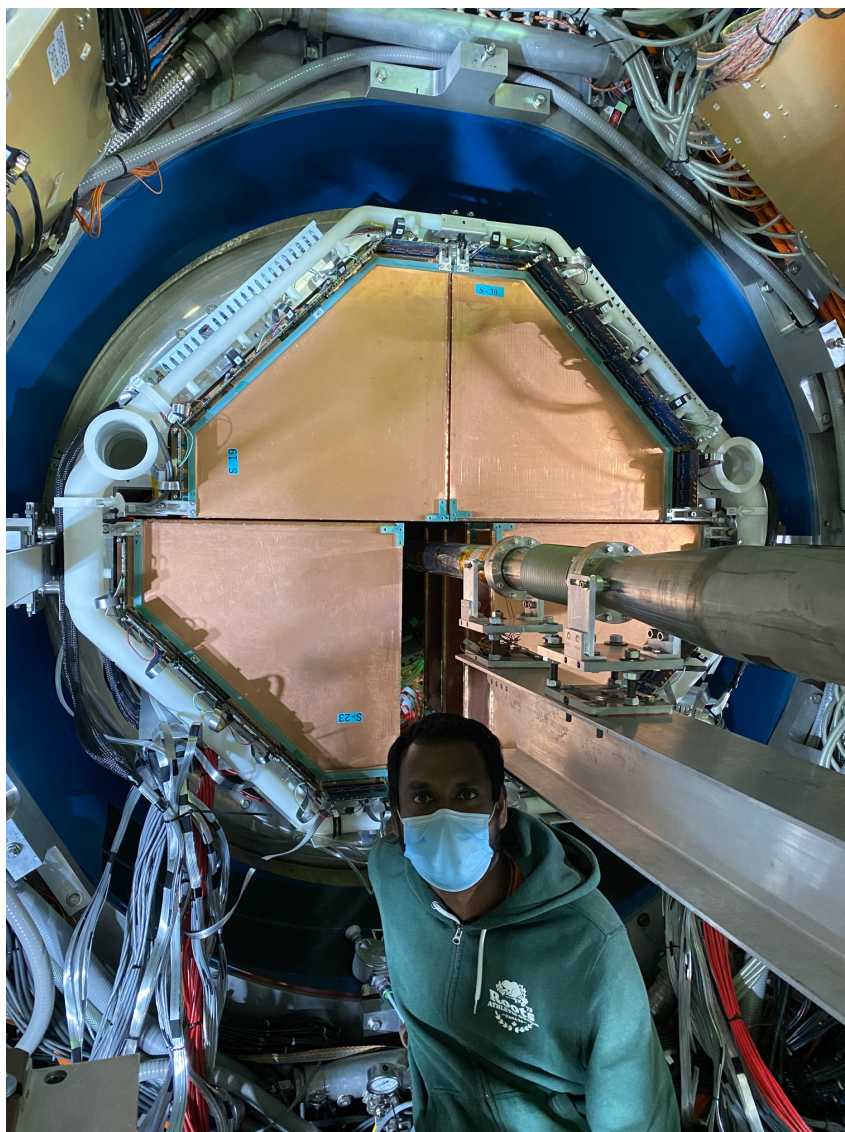
Table 2: Proposed Run-21 assuming 24-28 cryo-weeks, including an initial one week of cool-down, one week for CeC, a one week set-up time for each collider energy and 0.5 days for each FXT energy.

Single-Beam Energy (GeV/nucleon)	$\sqrt{s_{NN}}$ (GeV)	Run Time	Species	Events (MinBias)	Priority
3.85	7.7	11-20 weeks	Au+Au	100 M	✓
3.85	3 (FXT)	3 days	Au+Au	300 M	✓
44.5	9.2 (FXT)	0.5 days	Au+Au	50 M	✓
70	11.5 (FXT)	0.5 days	Au+Au	50 M	✓
100	13.7 (FXT)	0.5 days	Au+Au	50 M	✓
100	200	1 week	O+O	400 M	✓
8.35	17.1	2.5 weeks	Au+Au	250 M	✓
3.85	3 (FXT)	3 weeks	Au+Au	1.7M	✓
100	200	8 days	d+Au	200M	4 ✓

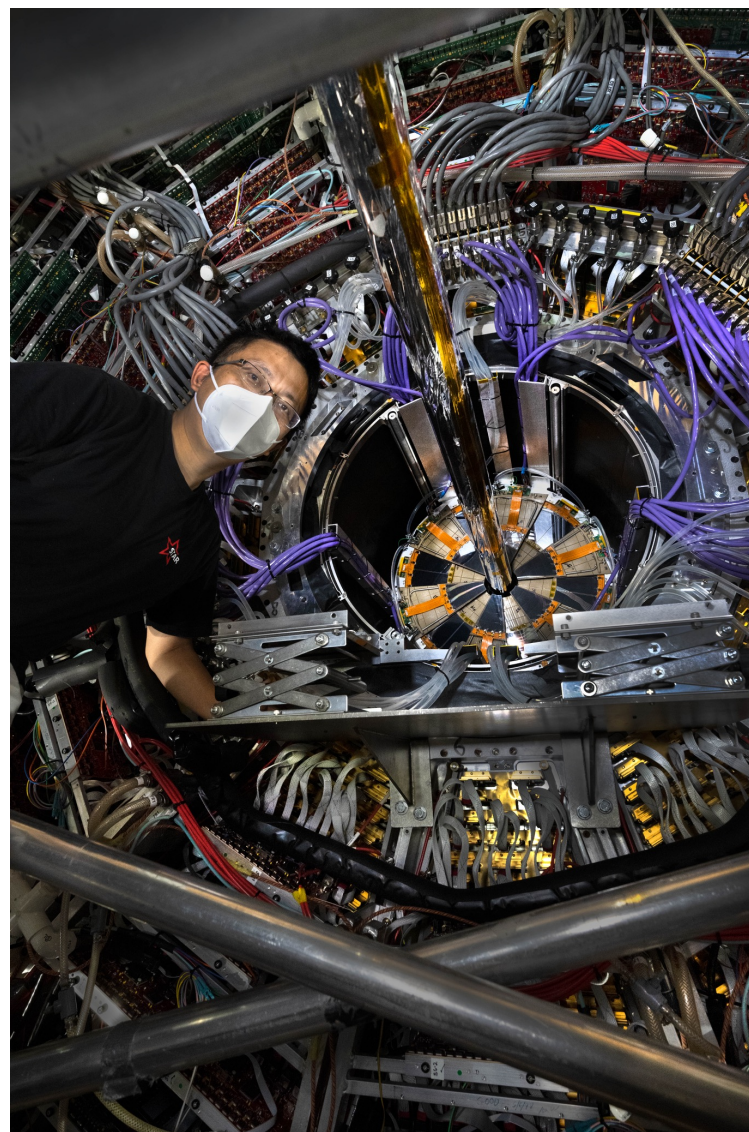
(additional mode on short notice)

+ 2 dedicated weeks for the Coherent electron Cooling Proof-of-Principle experiment (CeC X)

STAR completed forward upgrade, data taking successfully in RUN 22



Small thin gap chamber



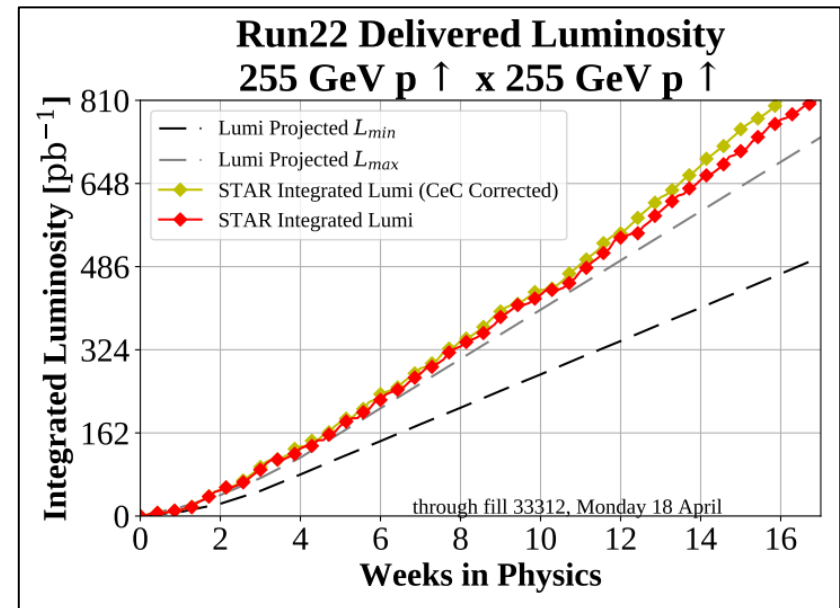
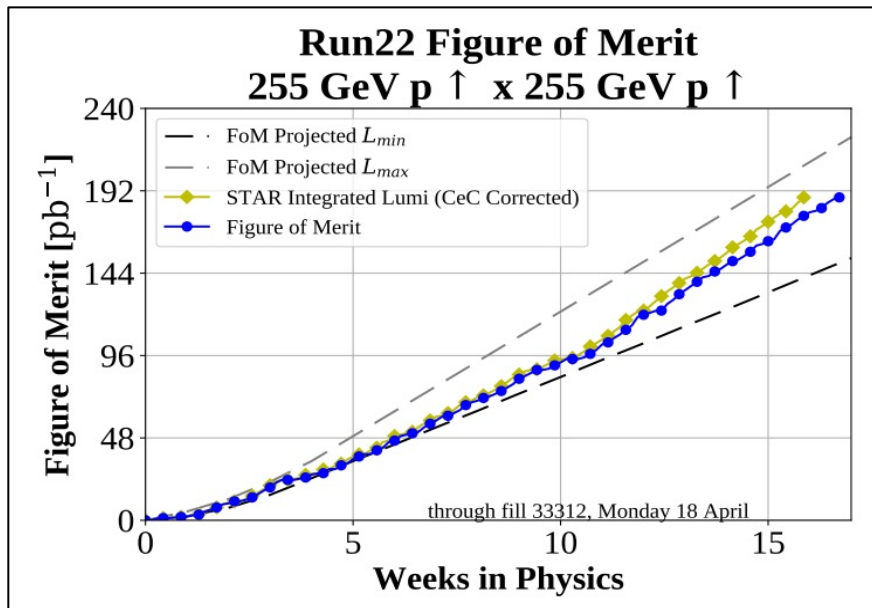
Silicon vertex tracker

RHIC Run 2022

Goals

Run Coordinator: Vincent Schoefer 2-week extension

- $p\uparrow+p\uparrow$ polarized proton collisions at full energy (~ 508 GeV c.o.m.) with new STAR forward detector upgrade
 - forward program: 107%, exceeding the goal
 - mid-rapidity: $\sim 98\%$, achieving the goal
- demonstration of Coherent electron Cooling (CeC-X)
 - demonstrated Plasma Cascade Amplification (PCA) with high gain, which is a prerequisite for cooling, however demonstration of coherent electron cooling was not achieved



RHIC Run Scenarios 2022-25

(presented to ONP in FY2024 budget Briefing)

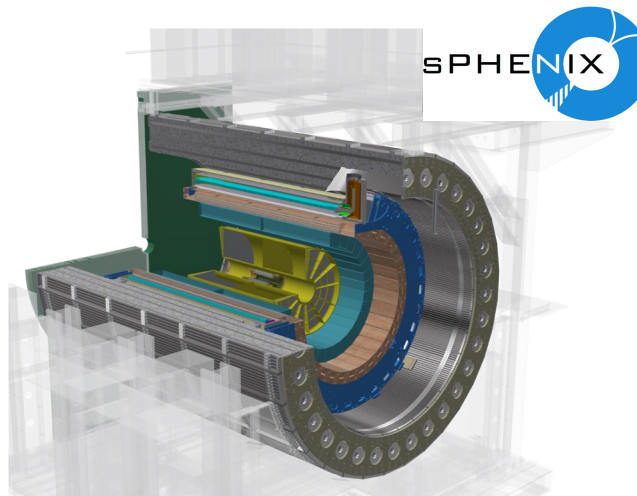
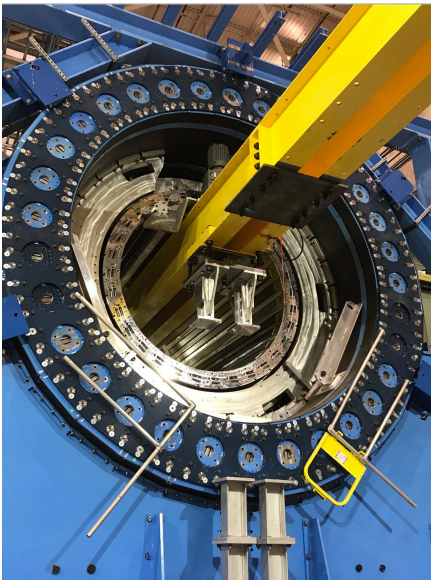
Year	Budget Scenario 1	Budget Scenario 2
2022	22 cryo-weeks with fSTAR p↑+p↑ at 510 GeV	22 cryo-weeks with fSTAR p↑+p↑ at 510 GeV (20 weeks)
2023	24 cryo-weeks with sPHENIX and STAR Au+Au at 200 GeV	28 cryo-weeks with sPHENIX and STAR Au+Au at 200 GeV
2024	24 cryo-weeks with sPHENIX and STAR p↑+p↑ and p↑+Au at 200 GeV	28 cryo-weeks with sPHENIX and STAR p↑+p↑ and p↑+Au at 200 GeV
2025	24 cryo-weeks with sPHENIX and STAR Au+Au at 200 GeV	28 cryo-weeks with sPHENIX and STAR Au+Au at 200 GeV



Completing the 2nd RHIC Goal in 2015 LRP

sPHENIX: Study QCD phenomena discovered at RHIC on different scales with unprecedented precision – How does the structureless “perfect fluid” emerge from the underlying asymptotically free gauge theory?

- Extend RHIC kinematic reach and capabilities for direct comparison with the LHC
- Focus on hard probes (jets and heavy flavor)



RHIC data taking scheduled for 2023–2025
sPHENIX upgrade will fully utilize the enhanced
(~50 times AuAu design) luminosity of RHIC together with STAR

RHIC/AGS Program Advisory Committee Meeting

- Meeting dates: June 2-3, 2022 (hybrid)
- Charge
 - STAR: Beam Use Requests for Runs 23-25
 - sPHENIX: Beam Use Requests for Runs 23-25
- Presentations
 - PHENIX: Status of data analysis and data preservation
 - STAR: Run 2022 report and Cold QCD Update, Heavy Ion Update on BES-II and Isobars
 - sPHENIX: Installation Status and Schedule including TPOT, Readiness for Data Taking including Computing and Commissioning plan
 - Run 2022 Results and Findings from CecX
- PAC written report expected soon

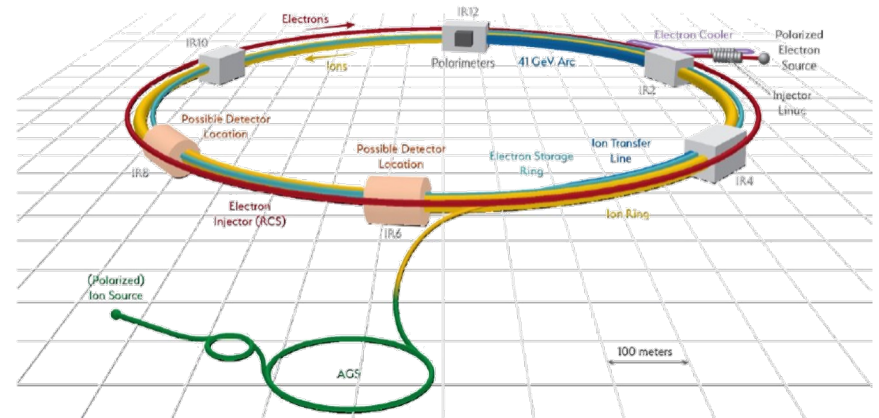
<https://indico.bnl.gov/event/15148/>

The Electron-Ion Collider

Project Design Goals

- High Luminosity: $L = 10^{33} - 10^{34} \text{ cm}^{-2} \text{ sec}^{-1}$, $10 - 100 \text{ fb}^{-1}/\text{year}$
- Highly Polarized Beams: $\sim 70\%$
- Large Center of Mass Energy Range: $E_{\text{cm}} = 20 - 140 \text{ GeV}$
- Large Ion Species Range: protons – Uranium
- Large Detector Acceptance and Good Background Conditions
- Accommodate a Second Interaction Region (IR)

Conceptual design scope and expected performance meet or exceed NSAC Long Range Plan (2015) and the EIC White Paper requirements endorsed by NAS (2018)



Double Ring Design Based on Existing RHIC Facility



Major milestones: CD-0 December 2019; DOE EIC site (BNL) selection on Jan 9, 2020; CD-1 June 2021; EIC project detector reference design selected in March 2022

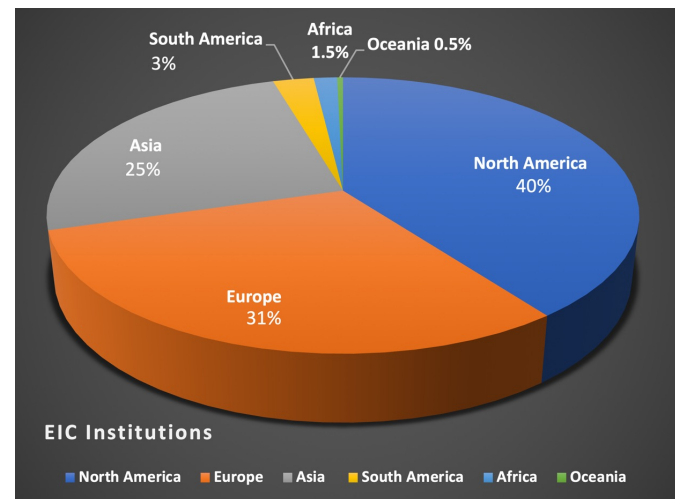
World-Wide Interest in EIC Physics

The EIC Users Group: [EICUG.ORG](https://www.eicug.org)

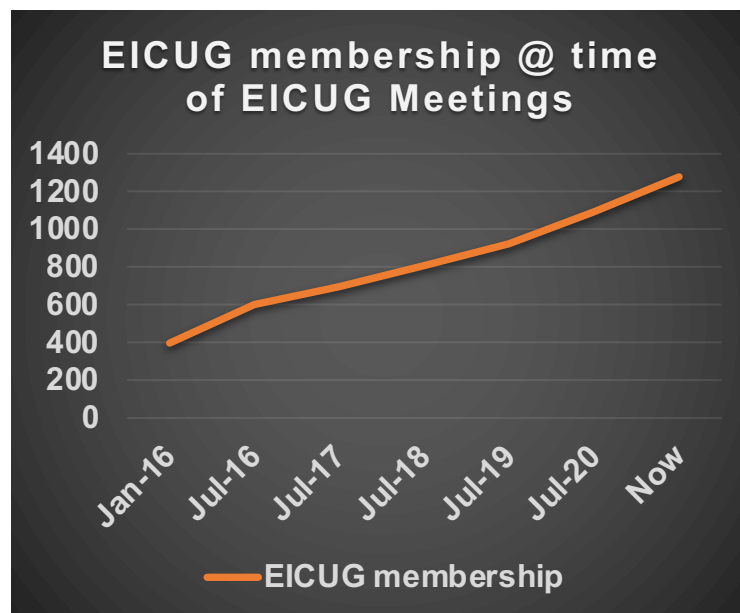
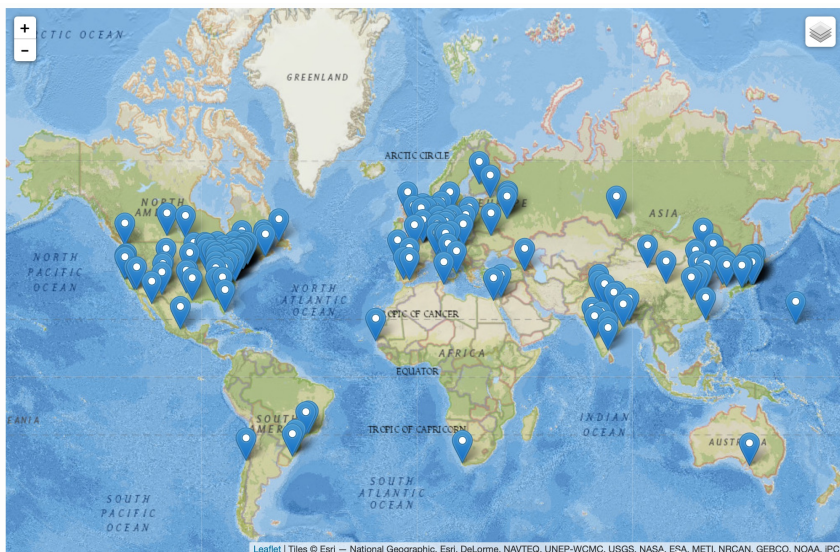
Formed in 2016, Current Status

1307 collaborators, 36 countries, 265 institutions
(Experimentalists 810, Theory 325, Acc. Sci. 159)

- EICUG has continuously grown since its formation, notably after CD-0 and site-selection
- Growth will continue as EIC project moves into construction



Location of Institutions



Yellow Report



“Yellow report”
laying out physics
case, detector
requirements, and
evolving detector
concepts
arXiv:2103.05419

Call for Proposals

Issued jointly by BNL and JLab
in March 2021 with input from DOE and
the EIC User Group.

Three proposals received on 12/1/2021
(ATHENA, CORE and ECCE)

Electron-Ion Collider

GOALS THE MACHINE BENEFITS SCIENCE NEWS IMAGES

Call for Collaboration Proposals for Detectors at the Electron-Ion Collider

Brookhaven National Laboratory (BNL) and the Thomas Jefferson National Accelerator Facility (JLab) are pleased to announce the Call for Collaboration Proposals for Detectors to be located at the Electron-Ion Collider (EIC). The EIC will have the capacity to host two interaction regions, each with a corresponding detector. It is expected that each of these two detectors would be represented by a Collaboration.

Detector 1 is within the scope of the EIC project and should be based on the “reference” detector described by the EIC User Group (EICUG) in the Yellow Report (YR) and included in the EIC Conceptual Design Report (CDR). This detector must satisfy the requirements of the EIC “mission need” statement based on the EIC community White Paper and the National Academies of Science (NAS) 2018 report. US Federal funds are expected to support most but not all of the acquisition of Detector 1. It is currently planned to be located at Interaction Point 6 (IP6) on the Relativistic Heavy-Ion Collider.

Detector 2 could be a complementary detector that may focus on optimizing particular science topics or address science topics beyond those described in the White Paper and the National Academies of Science (NAS) 2018 report. Detector 2 would reside at a different Interaction Point from Detector 1 and is currently not within the EIC project scope. Routes to make Detector 2 and a second interaction region possible are being explored.

Recommendations from DPAP

- “The panel unanimously recommends ECCE as Detector 1. The proto-collaboration is urged to openly accept additional collaborators and quickly consolidate its design so that the Project Detector can advance to CD2/3a in a timely way.”
- “The panel supports the case for a second EIC detector, however, given the current funding and available resources, the committee finds that a decision on Detector 2 should be delayed until the resources and schedule for the Project detector (Detector 1) are more fully realized.”

Physics Performance; Detector Concept and Feasibility; Electronics, DAQ, Offline; Infrastructure, Magnet, and Machine Detector Interface; Management and Collaboration

Strength of Collaboration

“The three proto-collaborations are led by experienced, strong leadership teams. ATHENA and ECCE also have expert and experienced international collaborators, as demonstrated by the well-developed state of the proposed conceptual designs prepared in a relatively short period of time, and by the organization of the effort to produce these designs and of the proposals. This accomplishment is truly impressive.”

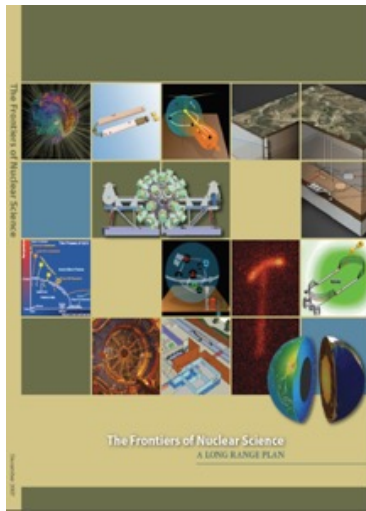
Development following DPAP recommendations

A Key Point from DPAP

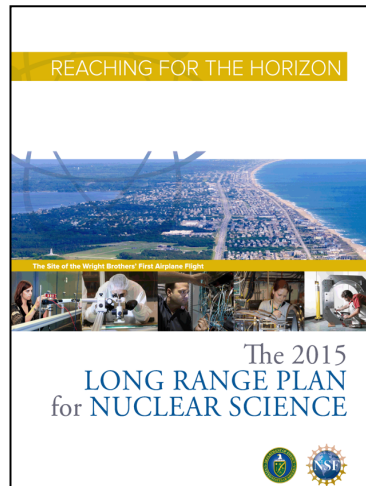
“In order to ensure that the EIC has a maximally optimal Detector 1, the proto-collaboration for a concept selected for Detector 1 must be open to: (1) integrating new collaborators in a manner that enables them to make contributions that impact the capabilities and success of the experiment in significant ways, including some new collaborating individuals and groups into positions of responsibility and leadership; and (2) integrating new experimental concepts and technologies that improve physics capabilities without introducing inappropriate risk.”

- Priority goal is to establish collaboration for project detector and consolidate the design – ongoing and being coordinated by the EIC project team
- A joint leadership team has formed between ATHENA and ECCE with detector and physics working groups
- Detector 1 first General Meeting took place April 29th, 2022:
<https://indico.bnl.gov/event/15371/>
- Pursuing a path forward towards the 2nd detector with the highest priority on the project detector

Upcoming NSAC Long Range Plan



**NSAC
LRP
2007**



**NSAC
LRP
2015**



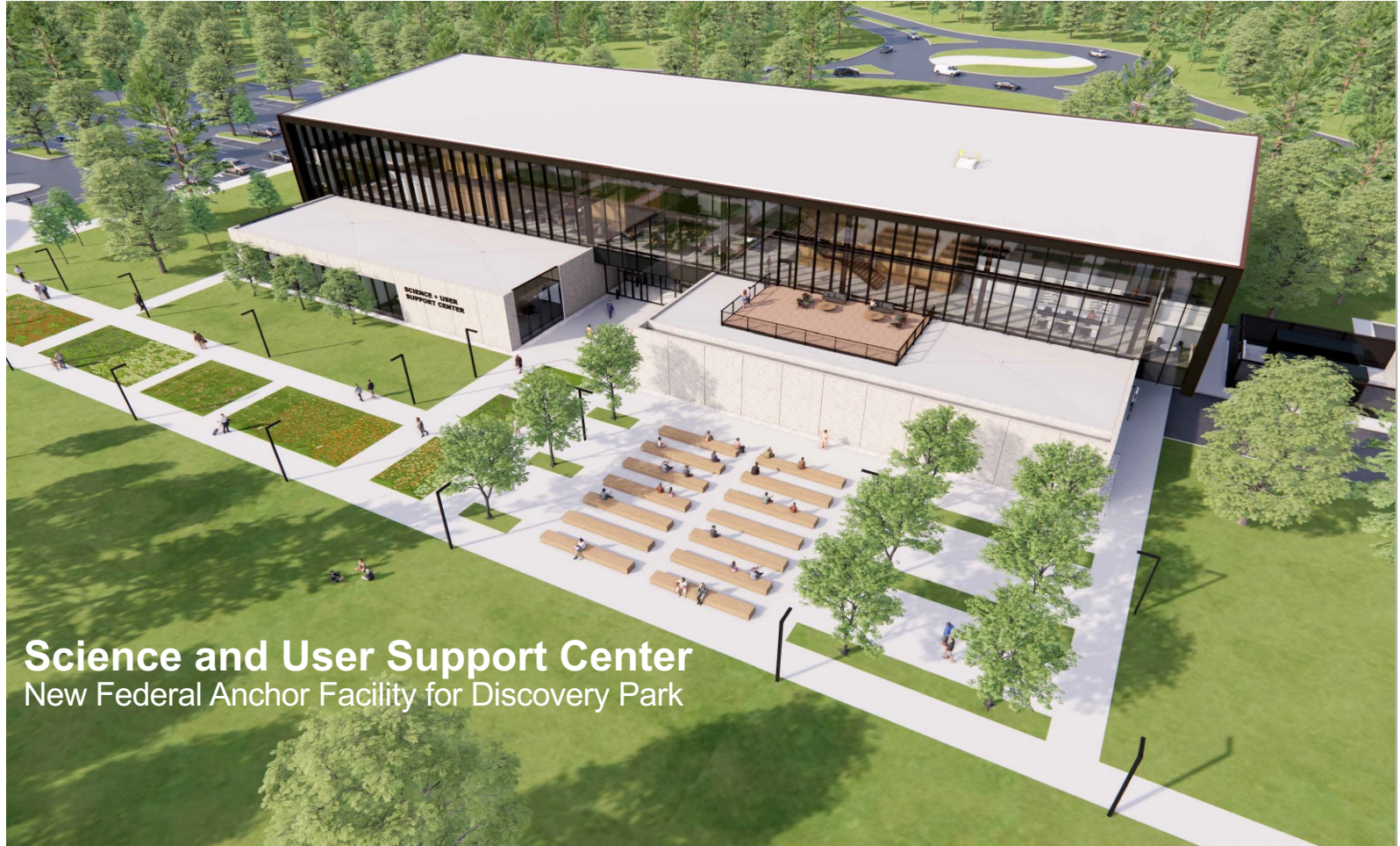
Next LRP

**NSAC
LRP 2022-
2023**

- LRP charge anticipated July 2022 NSAC meeting (Tim Hallman and Allena Oppen)
 - DNP starts to pre-plan for Townhall meetings in consultation with NSAC, DOE and NSF
 - Hot and Cold QCD
 - Nuclear Reactions, structure and Astrophysics
 - Fundamental Symmetries, Neutrinos, Neutrons,...
- (Education, DEI, cross cutting areas and applications (including computing, nuclear data, isotope, accelerator) will be integrated)

Update on some users' concerns

- Site access in the pandemic
 - No longer requires one person per apartment
 - Improved communications to users about site access
- Quality of life issues
 - Legal names only on badges – a difficult and highly regulated issue
 - Lack of gender-neutral bathrooms and dorms – preliminary design, work estimated, proposal supported, waiting on funding (Bldg.153)
 - Concerns about onsite housing/living conditions
 - apartments (or being) renovated
 - Challenging onsite food situation – The SOW has been submitted to Procurement for an RFI for Cafeteria services. We anticipate increased need of immediate food services onsite with the students and will add more food trucks, pop-ups, etc. accordingly.
 - What will happen with lodging when Discovery Park (DP) opens
Is this stable, affordable, functional? Is there reliable 24/7 transportation to the lab? The plan is to expand shuttle service to DP area once development is complete with SUSC and a future loop service will be considered when the area has more development.



Science and User Support Center

New Federal Anchor Facility for Discovery Park



- Start of Construction (Site Prep.): April 2022
- Total Project Cost: \$86.2M
- Construction Contract: \$62M
- 75,000 GSF. Future Occupants: Guest Services, Badging, Human Resources, Housing, GUV Center, Conference Center



Thank you for your attention!